Understanding consumption: Why and how do we use products?

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CENTRE FOR INDUSTRIAL ENERGY, MATERIALS AND PRODUCTS

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- Efficiency gains that can be made in industry, including use of heat and improvements in processes.

- Changing the use of materials needed to make products, including material substitution, light weighting and circular economy.

- Changing the way the final consumer (industry, households or government) use products to reduce energy demand, including product longevity and shifts from goods to services.

CIE-MAP brings together the four leading UK universities - Bath, Cardiff, Leeds and Nottingham Trent - that offer a range of multidisciplinary expertise. Funded by the Research Council's Energy Programme, CIE-MAP forms one of six centres focused on reducing energy demand in the UK.

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Introduction

Consumption is a key driver behind demand for materials and energy. This report explores the factors that determine consumption in order to identify opportunities to move towards a low carbon future.

Our first report identified and described energy and material-intensive products that are consumed in the UK at different points along the supply chain (see Figure 1). It concluded that reductions in consumption are needed to achieve national climate change targets. This report focuses on consumption patterns and the final demand for products. All products are made from materials that embody energy (i.e. energy inputs required to make them) and the use of these materials in products is thus an important (and somewhat neglected) element in debate on climate change.

This report explores current understanding of consumption and then considers proposals for making and scaling up change. Consumption is understood in part through analysis of socio-demographic and industry trends but also by considering how value is perceived by consumers. There may be significant differences in what influences the three actors in consumption – households, industry and government or institutions (hereafter 'institutions'); these are noted and will inform the development of future research.

This second report draws some key conclusions:

- Consumption is multifaceted, influenced by individual values and attitudes and wider social and cultural practices. Understanding and changing patterns of consumption requires a multidisciplinary approach (e.g. psychology, sociology, design, economics and business management).
- Each actor is driven by different perceptions of value. Definitions of value are complex and include a product's monetary cost in relation to its functionality, but meanings of value extend beyond this: to socio-cultural values in the case of households, corporate social values in industry, and how value is considered in procurement decisions made by institutions.
- Design can play a crucial role in achieving low material consumption as it acts at the interface between consumers and products. Design strategies can be applied to reduce materials use at different stages in the product life cycle. Engagement with the whole supply chain and an evaluation of trade-offs is needed to find appropriate opportunities to reduce the use of materials.
- Current barriers, acting on multiple levels, can be transformed into triggers for change and their impacts scaled up, especially if aligned to social trends, emerging markets and government policies.
- Policy interventions can facilitate the process to reduce the emissions-intensive material and energy demand associated with the production of goods and services for final demand.

This report will be of interest to researchers, industries and policy makers seeking change in consumption towards lower material use. The concluding section describes how we aim to contribute towards the achievement of this goal.

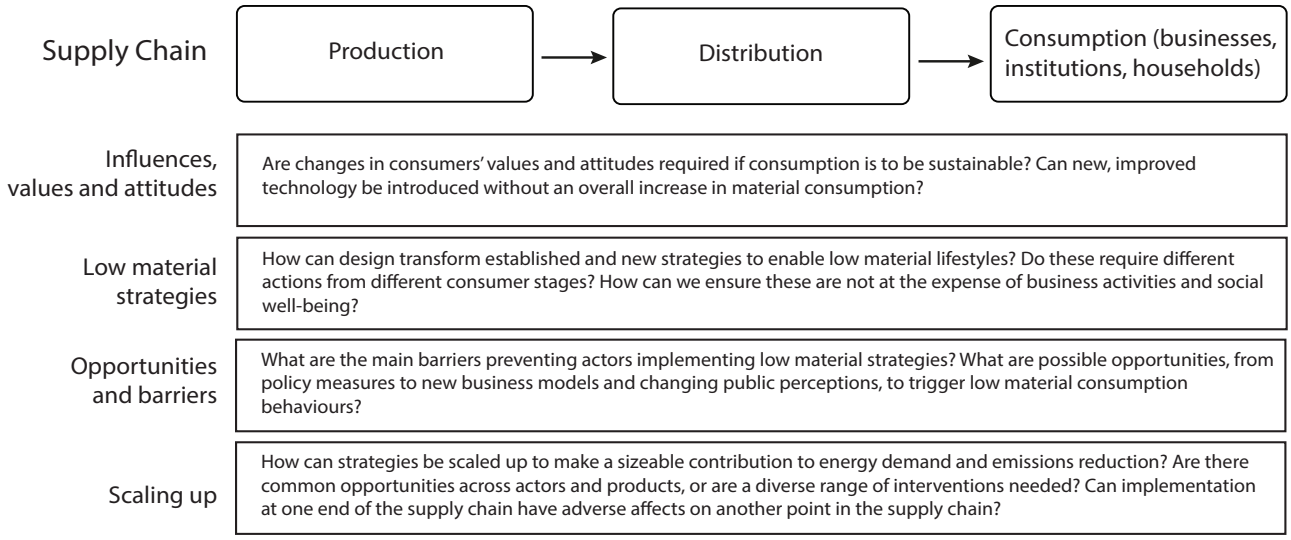


Fig 1: Research questions concerning opportunities for low material consumption along the supply chain.

How is UK consumption a driver for global material demand and emissions?

Changing unsustainable patterns of consumption is recognised as a priority on a global scale. The UK is committed to reduce national territorial emissions 80% by 2050. The five most carbon-intensive materials – steel, cement, paper, plastics and aluminium – are mainly consumed in the UK in the form of buildings and infrastructure, vehicles, and electrical and electronic equipment. This report examines the importance of electrical and electronic equipment, which accounts for a significant share of the UK demand for steel and plastics.

The importance of reducing material consumption and emissions for the UK

Consumption drives material demand and related carbon emissions. The significance of consumption to environmental sustainability has been recognised for more than two decades. In the Agenda 21 report produced for the 1992 United Nations Conference on Environment and Development, international government representatives stated that "the major cause of the continued deterioration of the global environment is the unsustainable pattern of consumption and production, particularly in the industrialized countries. [...] We must examine the demand for natural resources generated by unsustainable consumption, and seek ways of using resources that minimize depletion and reduce pollution."

The improvements in sustainable consumption achieved since then have, however, proved inadequate. Increasing final spending on goods and services in the UK has led to more greenhouse gas (GHG) emissions than has been mitigated by more efficient production.

The industries that produce materials are energy-intensive but have become highly efficient in their use of energy. Reducing their GHG emissions therefore implies a reduction in their material output,[1] which requires changing consumption patterns. However, such reductions in material output may affect the type of service provided, as delivering the same product quality while using less material can be technologically challenging.

Furthermore, nearly 50% of emissions generated for UK final consumption are emitted overseas but these are not captured within the UK's climate change target, which is to reduce territorial emissions by 80% from 1990 to 2050. Some of these overseas emissions are managed under the EU Emissions Trading Scheme but a growing proportion, currently around 60%, are produced in emerging and less developed economies.

This complexity requires a systemic approach to improve energy and material efficiency across the supply chain of materials, comprising resource extraction, production, distribution, retailing and use.

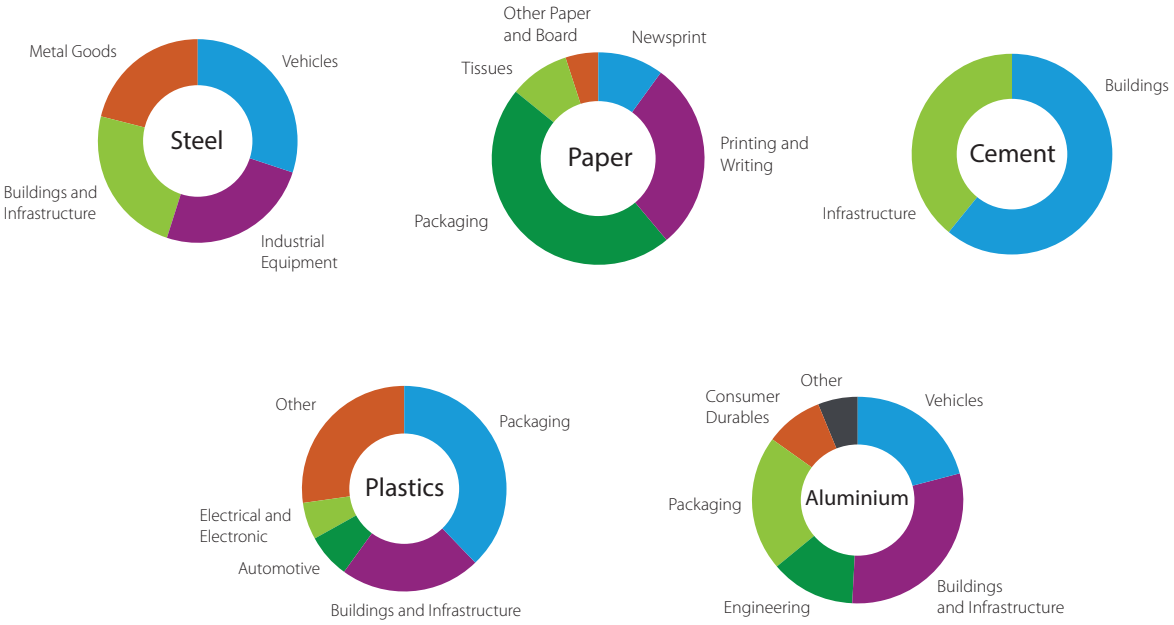
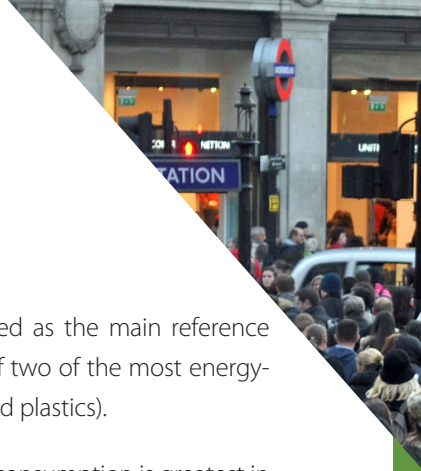


Fig 2: Use of five key materials to manufacture goods purchased in the UK: steel (20Mt), paper (12Mt), cement (11Mt), plastics (5Mt), and aluminium (1Mt).

Source: Cabrera Serrenho, A. et al. The role of consumption in material reduction opportunities. In Cooper, T. et al., (eds) (2015) PLATE Conference Proceedings, Nottingham Trent University.



Products embodying emissions-intensive materials

More than one third of the global GHGs caused by all human activities, excluding land-use changes, arise from industry activity. More than half of worldwide industrial emissions result from the production of five key materials: steel (25%), cement (19%), paper (4%), plastics (4%) and aluminium (3%). The charts in Figure 2 show in which products these materials are embodied for the UK.

For example, electrical and electronic equipment (EEE), such as domestic appliances and ICT, is a resource-intensive sector that has experienced rapid growth in recent years. EEE requires inputs from four of these materials, which account for significant shares in its composition: 55% of the average mass of EEE is iron and steel, 27% is plastic and 2% is aluminium. WRAP (the Waste & Resources Action Programme) has found EEE to have some of the highest resource impacts within the UK market, emphasising the urgent need to reduce material use within this product category (see Figure 3). EEE - in particular washing machines and laptops - are used as the main reference in this report due to their use of two of the most energy-intensive materials (iron/steel and plastics).

For many EEE products, energy consumption is greatest in the use phase and in addressing GHGs many governments have thus focused on energy efficiency. However, increased efficiency in use may imply more frequent replacement, and greater embodied carbon impacts through accelerated production may offset efficiency gains. Rapid technological developments, of whatever kind, result in greater turnover rates and fully functioning products continue to be sent to landfill.

Understanding consumption patterns that lead to high environmental impacts is necessary when efficiency improvements are not enough to reduce resource use and carbon emissions to sustainable levels. More research is evidently required to understand how to reduce material demand. The next section describes how consumption is addressed by different disciplines in order to identify possible levers for change.

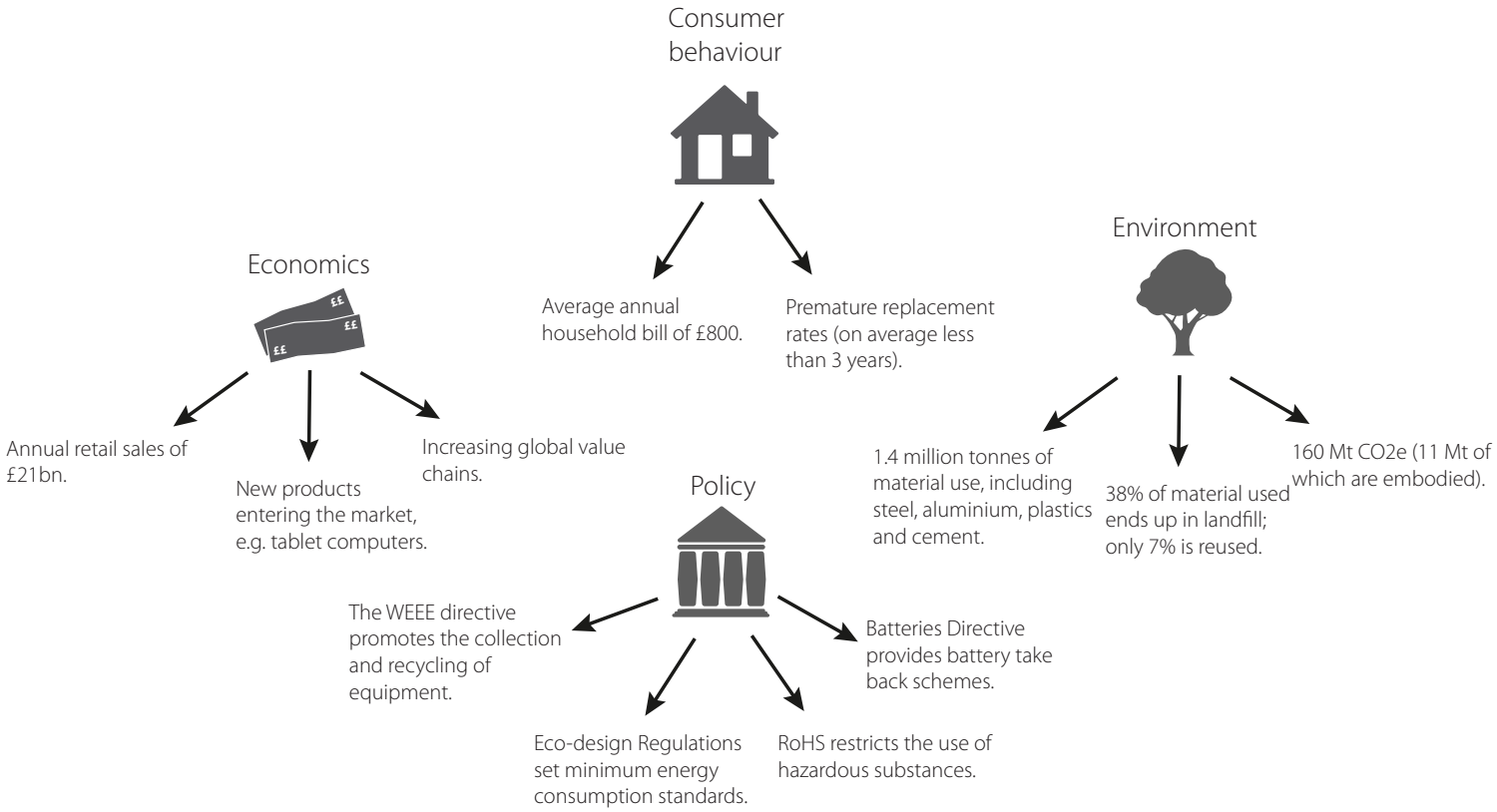


Fig 3: Market size, impacts and policy implications of electrical and electronic equipment.
Source: Data from WRAP (2013) Switched on to Value. Banbury, WRAP.

How is consumption understood?

In order to influence consumption it is important to go beyond approaches based on mainstream neoclassical economics and recognise the complexities of consumer behaviour. Individuals are not only driven by a desire to maximise utility or profit; they are also influenced by values, attitudes and habits and by their external environment.

Defining consumers

Consumers vary widely and for practical purposes three types of consumer are defined and addressed in this report: households, industry and institutions.

Households are units of analysis where individuals are situated and make purchases either singularly or with and for others. For example, households tend to own one washing machine, yet several individuals in a household may own a laptop. Individuals within households will consume differently depending on demographics (such as income, employment, age and gender), attitudes and their living context.

Industries consume resources in order to produce goods or services for sale. At the highest level, the UK Standard Industrial Classification of Economic Activities defines 21 industrial sectors including manufacturing, construction, wholesale and retail trade. Within industry, larger companies often have a procurement team to manage their purchasing decisions.

Institutions are defined in this report as organisations providing a public service such as central government departments, local authorities, universities, schools, hospitals and charities. They can be either private or public, and are normally not-for-profit. Larger institutions tend to have procurement teams.

Explaining consumption

In mainstream neoclassical economics, a crude understanding of consumption decisions typically takes the form of cost-benefit analysis in which self-interested individuals make rational choices to maximise their well-being at minimal cost. By contrast, the discipline of behavioural economics attempts to embrace more fully the psychological and social underpinnings of consumption decisions, recognising that people (i) have insufficient knowledge, (ii) make choices on the basis of receiving immediate positive feedback, (iii) make decisions based on personal experience, and (iv) perceive some forms of behaviour as socially unacceptable.

Methods such as life cycle assessment, environmentally-extended input-output analysis and material flow analysis are accounting tools developed to assess resource use and environmental degradation from consumption activities. Progress towards sustainability is generally assessed by measuring the impacts generated by a portion of the elements involved in a typical supply chain (see 'Measured' box in Figure 4). What is measurable tends to be addressed and may be improved over time, but what is not is often ignored. While such models indicate progress towards some measure of sustainability, their purely accounting nature ignores the complex dynamics of 'why' and 'how' people consume (and thus summarised outside the 'Measured' box in Figure 4). There are a multitude of influences upon purchasing decisions across the different consumer groups, and these can be difficult to identify, let alone quantify. Research studies have generated knowledge on this topic, yet it is not collected as part of national accounts or in a structured way. A growing number of studies on the culture of consumption have revealed the complex individual (internal) and contextual (external) drivers

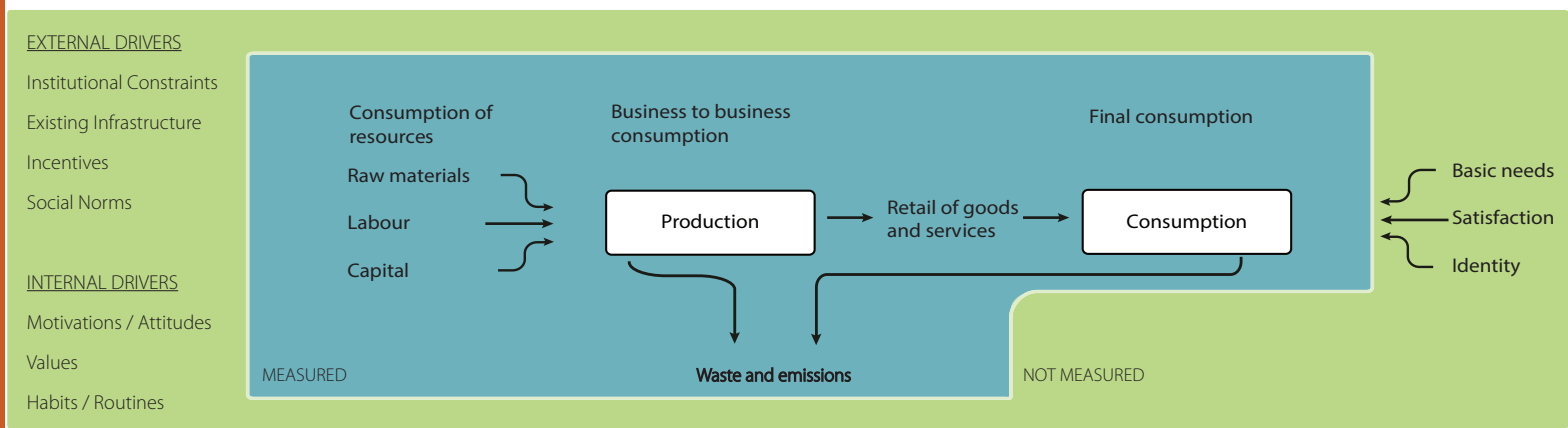
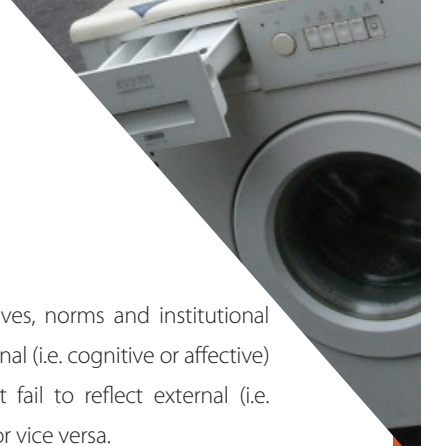


Fig 4: Influences upon consumption through a typical supply chain. What is measured is highlighted in blue.

Source: Adapted from Jackson, 2005, Motivating Sustainable Consumption: a review of evidence on consumer behaviour and behavioural change, Centre for Environmental Strategy, Surrey University.



that have shaped consumption patterns during the past half-century (see Figure 4).

In the case of industry and institutions, decision making is influenced by external factors such as costs, the operating environment, market system, sector characteristics, regulation and public attitudes, together with internal values, standards, procedures, culture and structure. The complexity involved in understanding consumer decisions is highlighted in Box Story 1. Mainstream neoclassical economics, which has underpinned environmental policies, tends to neglect the unmeasured dynamics in consumption and thus offers only limited insights into consumer behaviour.

Advances in understanding consumption

Theories drawn from other disciplines (sociology, psychology, marketing) have challenged economics-based understandings of consumption, mainly at a household level. For example, they reject the assumption that people only act out of self-interest, and acknowledge that there may be non-rational reasons for acquiring goods and that possessions influence the way people feel about themselves and each other.

Consumption is an activity that is intended to satisfy needs, improve the self, enable new capabilities and define social relationships. Changing towards more sustainable, low material, patterns of consumption implies understanding both internal and external elements of consumption. Some consumer behaviour models focus on internal antecedents of behaviour such as values, attitudes and intentions, while others focus more on external factors such as incentives, norms and institutional constraints. They may describe internal (i.e. cognitive or affective) aspects of individual decisions but fail to reflect external (i.e. contextual or situational) variables, or vice versa.

Policy interventions aimed at encouraging change tend to have been informed by social psychological theories that focus on attitudes and behaviour. However, policies for behaviour change have not necessarily proved effective. A gap between stated intention and actual action can be generated by circumstantial conditions and personal attitudes, resulting in no change in behaviour or even negative rebound effects. In response, alternative theoretical perspectives have emerged, most notably social practice theory.

The next section explores how economic, social and environmental values influence consumption decisions of households, industry and institutions. The perception of value influences consumption for each of these three actors, although this issue has been less explored for industry and institutions. Better understanding of the influences upon value could help to explain decision making and suggest areas for more effective interventions to encourage sustainable consumption. To this end, a scoping study was conducted comprising an industry seminar and a review of procurement within an institutional context,[2] findings of which are reported in the next section.

Price vs. quality and durability: The case of an ISE Washing Machine

BOX STORY 1

Appliance repairers have long been aware that the durability of products has declined over recent decades. By the turn of the millennia they reported that failures often occurred at an early age, even within warranty periods, which would previously have been unthinkable. The organisation UK WhiteGoods was created to supply washing machines solely through repairers or retailers who deliver, install and repair machines, believing that this would offer a better service than national retail chains. In 2007, it established Independent Service Engineering Limited (ISE) and offered washing machines with different length guarantees (2, 5 and 10 years), a full service for the machines and a 24/7 phone service staffed by qualified technicians. As customers tended to choose the less durable models at the lower price, however, the business model did not work as intended. Customer feedback suggested that they commonly experienced early failure of products, which ISE attributed to misuse (e.g. overloading and excessive detergent use) and thus repairs were not covered by guarantees.

ISE realised that many clients wrongly assumed that cheaper, lower specification models were of inferior build quality. Such dissatisfaction and confusion among customers led the company to change strategy in 2010 and supply only the higher specification products. In late 2014, however, it was forced to cease trading. The ISE experience shows the challenge of understanding consumers, since they may have a different understanding of and expectations towards product functionality and durability, and some put a priority on price over quality.

How does value shape consumption?

Purchase decisions are driven by interpretations of value which extend beyond monetary worth and take account of personal, family, socio-cultural values and, in the case of industry, corporate social values.

Households

How households value products is complex, typically shaped by the relationship between price and quality. Many consumers believe that a more expensive product will be better in quality, although studies have also revealed a disparity between price and quality. Quality is generally associated with functional reliability (i.e. performance) and durability (i.e. 'use value' over time). More expensive items may have a greater use value, as they can be expected to last longer. Most products depreciate through use, which may affect decisions to repair goods.

Consumers' willingness to keep products in use for longer is intimately bound to perceptions of value which include monetary worth and functionality (see Box Story 1) but may also be influenced by a desire to have something new. Fashion and this 'desire for the new' may be as important as functionality and durability in the purchase decision. People may feel under social pressure to update their belongings. Laptops and mobiles, for example, are often purchased for their fashionability and valued as status symbols and emblems of self-expression as well as their functionality.

Perceptions of value are influenced by people's personality and their circumstances (e.g. family and financial situations) as well as the product's characteristics. Value extends beyond monetary worth when linked to the meaning that an individual attaches to artefacts, their social or emotional value. In this context perceptions of value are seen to be directed by personal, family and socio-cultural values. In social psychology, behaviours are understood to be driven by individual values that serve as guiding principles in the life of a person or group and these influence consumption.

In order to achieve changes in consumer behaviour, further insights into how individuals perceive value are needed. Clearer understanding of the relationships between price, quality and longevity is required at household level, especially how attitudes towards a product can change over time; how this may be influenced by feelings concerning the product's performance; and how far it has met users' expectations.

Industry

How companies approach climate change and other environmental concerns is shaped by their corporate values, "socially shared cognitive representations of institutional goals and demands."[3] Corporate values influence a company's structure, identity and strategy and may align with a corporate social responsibility (CSR) agenda designed to enhance its competitiveness while improving the economic and social conditions of the communities in which it operates. Corporate social values can be reflected in procurement through an ethical supply chain, which will affect industry purchasing decisions and thereby generate social value by minimising environmental impacts and protecting human rights. From the consumers' perspective, they should be evident in brand identity and experienced as brand values.

How companies assess corporate values within their business models was explored at an industry workshop held in 2014. Representatives from supermarkets, electronic goods manufacturers and construction described their key corporate values as relevant to product quality, brand image and corporate identity. Participants indicated that these values can contribute to building consumer trust and loyalty and, consequently, increased sales.

In the context of the final consumer, the term 'value' was considered by participants to have a degree of ambiguity: it could be interpreted as affordability (value for money) or superior quality (relative value). As businesses are often driven

by demands for rapid turnover, product quality is not necessarily aligned with durability: mid-range and premium products may not prove durable, while some discount range products last longer than anticipated. This may reflect the disparity between quality, durability and price sometimes noted at household level.

Understanding how corporate social values and product (or brand) value are assessed at industry level and applied in practice in a company's decisions merits further exploration. Further research in this area could address how purchasing decisions are made with regard to quality and depreciation of value in relation to industrial equipment and assets; this would enable a comparison with the purchase of consumer goods by households.

Institutions

Influences upon attribution of value and purchasing decisions are currently less well understood for institutions than households, although the need for action to reduce their environmental impacts has been recognised.

In the case of government, for example, the EU has published recommended Green Public Procurement guidelines in order to increas resource efficiency and address other environmental impacts; public procurement accounts for 19% of the EU Gross Domestic Product (cf. 16% in the UK). The UK had a Greening Government Commitment to reduce GHG emissions and waste 25% by 2015 from a 2009-10 baseline. This included ensuring that redundant ICT equipment was reused or recycled, while the Government Buying Standard for Furniture required governmental departments to re-use furniture or purchase refurbished furniture. More generally, policy in central government is to work towards ensuring that whole life value for money is taken into account in procurement decisions and, through leading by example, to encourage the wider public sector to do the same. As 'green' public procurement should stimulate demand for less damaging products and services, there is a need to analyse which factors drive the inclusion of environmental criteria in public tenders.

To understand the influences upon attribution of value and purchasing decisions for institutions, a UK university's procurement policies and practices were studied through an exploration of its tendering process for laptops and other research equipment. In this case, procurement policy was designed to ensure that purchasing reflects the broader aim of the university of having a positive impact on the local environment, society and economy. It also works to encourage current and propspective suppliers to assess their social and environmental impacts and consider how to reduce them. The study revealed that value in this context is determined by specific criteria (e.g. price, duration of warranty), including product quality (by testing robustness and ease of maintaining, software compatibility), non-fundamental features and additional services, and sustainability specifications (e.g. WEEE compliance, energy ratings, sustainable and ethical supply chain).[4] The price of goods and equipment being considered for purchase is therefore related to the above criteria. For example, the cost of laptops is compared with their expected lifetime (which the university anticipates to be four years).

The individuals who purchase and assess the value of purchased items might have limited knowledge of the environmental implications of such items. Furthermore, they will have a personal set of values that might not match those of the institution and consequently there may be disparity between how an individual attributes value to products as a householder rather than as an employee. In order to address this, the university provides further guidance, tool kits and training to ensure that staff give due consideration to the sustainable impacts of their purchasing decisions.

The university example confirmed that some products within the institutional context may be costed over their whole lifetime, similar to practices within industry and government procurement. By contrast, households may different perceptions of the value of products depending on the type of product and expectations of its lifetime. Consideration of whole life cycle costing by households might lead to products being kept in use for longer and thus help to reduce material consumption.

In conclusion, the attribution of value presents many challenges. Further research is needed to identify the most influential drivers of consumption for all three actors. Consideration of the interrelationship of attitudes and behaviour between the three actors could reveal insights into opportunities for reducing material consumption. Potential triggers for change are identified and addressed below, in a subsequent section.

How can design support low material consumption?

Design can play a major role in achieving lower material consumption by acting at the interface between consumers and products through a multitude of strategies at each stage of the product life cycle and different points in the supply chain. Assessing the environmental, economic and social impacts of these design strategies is fundamental in order to set priorities and foresee possible rebound effects.

The role of design for low material consumption

The need to reduce material consumption has been addressed in theoretical models aimed at achieving economic and environmental benefits alongside increased well-being and social cohesion. For example, material consumption can be reduced through efficiency (i.e. more productive use), sufficiency (i.e. restrained use), or combining both. In this latter case products are replaced less frequently and more service from a specific amount of material is enabled. This presents the possibility that longer product life spans could contribute to material efficiency while also providing a route to sustainable consumption. Products would need to be manufactured to a high quality and maintained carefully, and this should result in employment opportunities that offset reduced demand for new products. The proposed approach, combining efficiency with sufficiency, would create less dependence on rising consumption for economic stability and challenge the assumption that lower consumption necessarily results in decreased wellbeing.

Design can play a crucial role in enabling the different patterns of consumption necessary to achieve low material consumption based on increased efficiency and sufficiency. The discipline of design aims at identifying and satisfying everyday needs through the conception and development of objects, systems and settings; it thus has a privileged position in addressing the need to change consumption patterns because it acts at the interface between people (i.e. users) and products. Designers interpret needs and values and their surrounding influences and thus have a key role in exploring the environmental, economic and social impacts of products and services within a multi-disciplinary dialogue on consumption.

The UK Design Council has estimated that 80% of the environmental impact of products is defined at the design stage. 'Design for sustainability' has emerged as a way of looking at these multiple impacts collectively rather than on a fragmented basis. In order to achieve low material consumption, design interventions are needed across the whole life cycle of a product, from material extraction to use and end-of-life, taking into account materials usage at each stage and engaging with stakeholders along the whole supply chain. The challenge to designers is to appreciate the breadth and depth of the agenda and their potentially pivotal role in enabling change.

Furthermore, a reduction in material consumption may demand business models that focus on the delivery of services (e.g. having clothing washed) rather than the sale of products (e.g. washing machines) to satisfy consumers' needs. This is an area that has been particularly investigated by designers in the context of product-service systems, which are widely considered to be environmentally advantageous. The goal of product-service systems is to meet the customer's needs while facilitating a reduction in environmental impacts caused by consumption.

The following sub-sections introduce design strategies that intervene at different stages in the product life cycle in order to support low material consumption. Potential environmental, economic and social impacts are considered.

Design strategies for low material consumption

In exploring the role of design, strategies for the reduction of material consumption have been selected from past research. They are grouped into four categories, corresponding to stages of the product life cycle at which the main impacts will occur (Figure 5).[5] A short description of each is presented below.

- Design with less use of energy-intensive materials: Strategies could be applied to select less energy intensive materials and use the optimal amount. An example is selecting materials that would reduce embodied carbon impacts.

- Design for manufacturing and distribution innovation: Strategies could be applied at the manufacturing and assembly stage of the production process. An example is minimising scrap, rejects, returns and yield losses.

- Design for optimising product life: Strategies could be applied at the use phase of the life cycle. User behaviour is an important consideration, and design-based

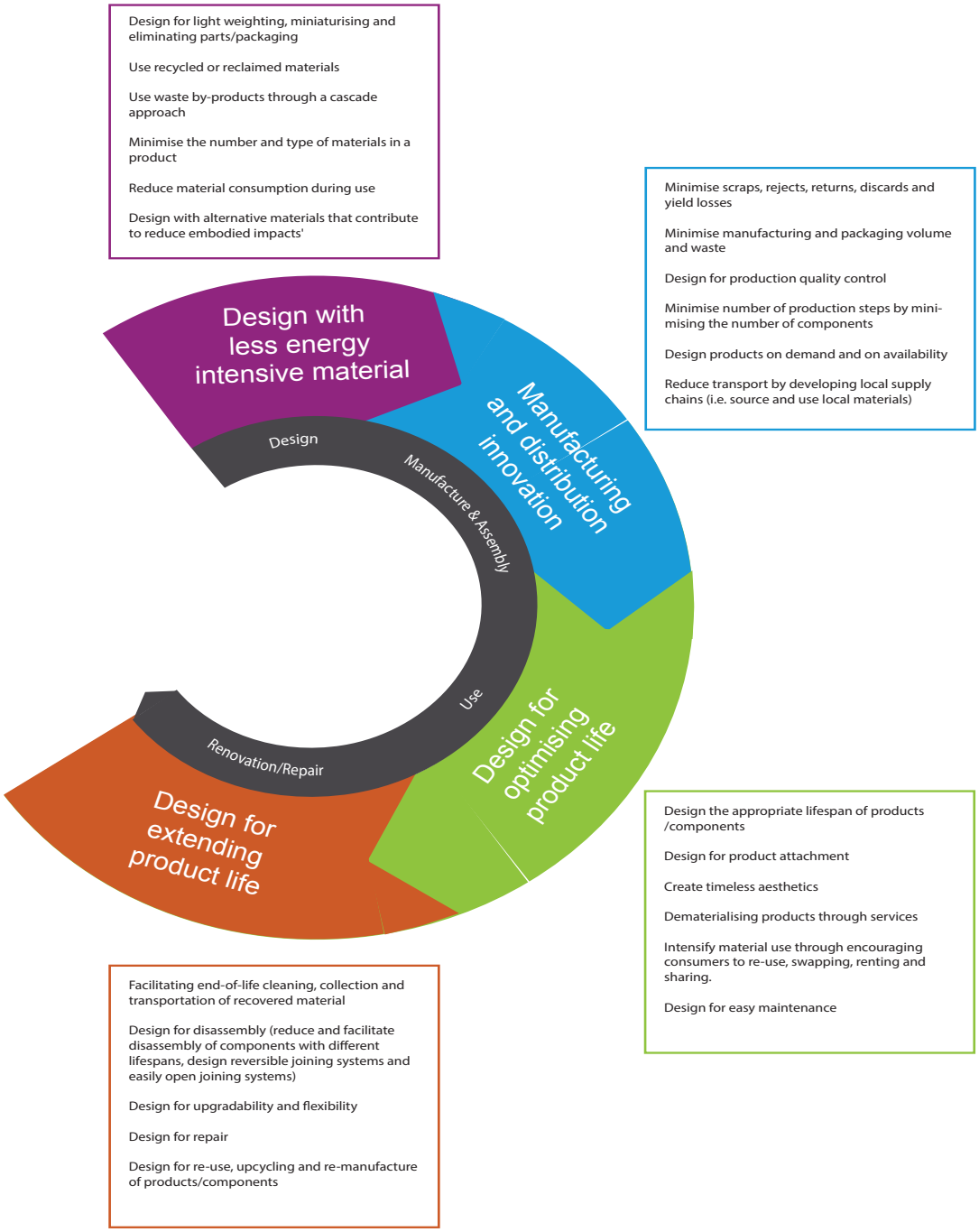


Fig 5: Design interventions for material reduction at different stages in the product lifecycle.

Design for less material consumption: the case of steel processing

BOX STORY 2

The industrial processes used to manufacture steel give rise to substantial process yield losses, embodying carbon emissions. Primetals Technologies Limited – a joint venture of Siemens, Mitsubishi Heavy Industries and Partners – have developed MULPIC®, an accelerated cooling system for steel plate. This process increases the yield strength of hot rolled steel while increasing its toughness, making it possible to use thinner gauge steel in various applications, as well as improving yield through more uniform plate properties. Unnecessary steel consumption is thus reduced. Another example from the same company concerns the design of a plate rolling mill. Its largest components (e.g. rolling mill housings) are designed to be durable and last throughout the asset lifetime. Smaller components (such as transmissions) are designed to be maintained and repaired. Other parts of the system are prone to technological obsolescence (including control and drive systems), so these are designed to be replaced and could potentially be remanufactured. This approach extends the lifespan of the plate rolling mill and also leads to business opportunities in the service market.

studies have linked sustainability issues to theoretical understandings of behaviour and consumption in the use phase.[6] An example is intensifying product use by encouraging consumers to reuse, swap or share underutilised goods.

- Design for product life extension: Strategies could be applied after the (first) use stage to facilitate repair or disassembly for component reuse. Examples include designing to facilitate disassembly of components with different life-spans and designing reversible and accessible joining systems.

Although these strategies can be used simultaneously, they may sometimes conflict and thus it is important to set priorities and evaluate trade-offs in relation to the primary aim of the company or project. Box Stories 2 and 3 give examples of how such strategies have been used in steel processing and the reuse of retailers' equipment and the benefits gained.

The environmental, economic and societal impacts of low material consumption strategies

Evidence is needed of the environmental, economic and social impacts of low material consumption strategies in order to ensure that they result in overall benefits, in particular because, historically, progress has been associated with increased material use.

National accounting systems are used to aggregate economic activity in a single measure, GDP (Gross Domestic Product), and to capture environmental impacts. Trends in economic activity have historically been used to assess societal well-being. Growth in GDP is commonly associated with progress despite growing evidence since the 1970s that, over the long term, increased income does not correlate with increased happiness, the Easterlin paradox. Moreover, countries with lower levels of GDP have been recorded as having greater well-being, or happiness, than those that are relatively rich.[7] This suggests that indicators other than GDP need to be used in developing future policy to ensure that economic progress is achieved without exceeding planetary boundaries or being at the expense of social priorities.

Low material consumption strategies need to be assessed against environmental and social indicators, alongside economic ones, to understand their overall impact. Benefits might include reduced resource use, waste generation and pollution, and less risk of climate change and other hazardous impacts (which often are felt most by poor and vulnerable communities). On the other hand, less use of virgin material may lead to increased energy use from material reprocessing and recycling activities, less employment in material-intensive sectors of the economy, and perceptions of a reduced quality of life.

Benefits and trade-offs in applying the four design strategies will vary on a case-by-case circumstance, depending on product categories, stakeholders and the context. Tools such as Life Cycle Assessment (LCA) can support the analysis of their impacts.

BOX STORY 3

Reusing and refurbishing equipment at Sainsbury's

The EU Waste Electrical and Electronic Equipment Directive (WEEE) aims to reduce environmental impacts arising from a growing industry sector. In order to facilitate the reuse of electrical and electronic equipment that has been removed from Sainsbury's stores and to ensure their compliance with UK WEEE regulations, Equipment Recycling Centres (ERCs) have been created by the company. Typically, a surveyor will make an assessment of the equipment in a store and identify anything unwanted and suitable to be sent to the ERC which, if necessary, may then be refurbished. All equipment suitable for reuse is listed on an inventory so that project managers can consider it for use in other store developments (e.g. new or refurbished stores, store extensions, etc). Project managers are required to check this inventory before placing orders for new equipment.

There is a clear environmental benefit in terms of the embodied carbon saved by reusing equipment instead of purchasing new. The ERC also aims to optimise use of delivery vehicles in order to cut transport costs, and thus carbon emissions. Any equipment that cannot be used because it no longer meets Sainsbury's current requirements is either sold or disposed of in an appropriate manner. A challenge faced by ERCs is when older equipment no longer meets current regulatory requirements (e.g. F-Gas regulations for fridges) and when the cost of refurbishment is higher than the cost of new items.

What are the barriers to and triggers for change?

The potential of the design strategies to achieve a transition to a low consumption future may be hampered by certain barriers. Households might feel locked into the norms of consumerism, industry might have financial concerns, and institutions might have regional constraints. Contemporary trends such as collaborative consumption and the circular economy could turn these barriers into triggers for change.

Households

Design for optimising product life and design for product life extension represent two strategies that offer opportunities for reduced material consumption by households, particularly within the use and end-of-life stages of a product's life cycle. Many consumers feel locked into a system of excessive consumption due to the commonly held assumption that increased affluence improves people's quality of life. The fulfilment of an individual's social and psychological needs has been closely linked to material consumption. However, material prosperity does not always signify well-being and decoupling well-being from escalated consumption may aid the move towards a low material consumption future.

Marketing drives faster replacement cycles by encouraging consumers to desire new products in order to express personal and social values through identity, status and social relationships. This 'desire for the new' may present a barrier for consumers to accept their role in alternative business models based on renting or other product-service systems. Re-engineering Business for Sustainability (REBUS) is a research project funded by Defra on the design and implementation of a pilot product-service system for baby and nursery equipment. The equipment is refurbished at the end of each life before being passed on to a new consumer with the aim of maximising resource efficiency by increased intensity of use.

A growing interest in collaborative consumption (the 'sharing economy') may trigger reduced material consumption while generating profit and has attracted interest from UK policy makers. Collaborative consumption, typically a peer-to-peer relationship in which goods and services are exchanged or shared, could aid well-being and enhance quality of life through greater social cohesion and participation.[8]

Alternative strategies for product longevity such as increased repair and maintenance are hampered by cost implications and willingness to pay. Making repair more attractive and feasible could be another trigger for change, namely through policy interventions such as VAT reductions for repair work and second-hand products. Longer warranties, eco-labels, access to service manuals, and support for professional networks have been proposed in order to increase the perceived value of repair over replacement. Grassroots movements have emerged around a growing interest in the extending product lifetimes through Repair Cafes, Hackspaces and Fab Labs, spaces where people come together to learn and engage in repair and making. Such spaces encourage the development of skills in maintenance, as well as fostering a sense of community. A different mode of consuming and keeping products in use for longer could influence how individuals value products, both in terms of their monetary worth and the meanings that they attach to them. Box Story 4 discusses these opportunities in more detail.

Industry

The move towards low material consumption for industrial organisations may be hampered by barriers such as inertia, producer lock-in, financial constraints and risk. In addition, supply chains can be complex and there is often a lack of transparency between suppliers. Economies of scale put commercial pressure on companies to increase sales volumes and may present a significant obstacle.

The fast-developing theme of a circular economy offers industry a potentially attractive proposition to move towards greater material efficiency. In contrast to the traditional linear economy model of 'take, make, dispose', it proposes a radical shift towards closed loop systems of production in which material is reused or recycled and waste transformed into value rather than sent to landfill. Research has shown that further benefits of a closed loop model may include economic growth and employment opportunities. Originating from cradle to cradle thinking primarily intended to be put into practice by individual companies, it has evolved into a more widely applicable model.

The circular economy approach is not without critics as its primary focus is material recovery and recycling, which requires energy and the continued input of virgin materials (albeit substantially reduced), thus generating additional environmental impacts. Strategies for product longevity such

as repair, upgrading and remanufacturing are generally more beneficial than recycling. There is opportunity to develop the circular model further to retain value from product longevity at business to business level.

Design thinking can inform business strategies to reduce material consumption and contribute to the circular economy. For example, initiatives such as the Restart Project (see Box Story 5) could inspire the emergence of new business models that focus on extending product lifetimes within a circular system.

Our future research will explore opportunities for design strategies to reduce material consumption across the supply chain.

Institutions

Any move towards reducing material consumption by institutions could face barriers. For example, regional institutions such as National Health Service trusts, local government and schools may find it challenging to implement national policies set by central government because of constraints at local level (including supply chain issues and budgets). Central government's move towards greener procurement policies could be an important trigger for change within the wider public sector.

However, such barriers to change have not yet been explored in depth for institutions. The example of university procurement (above) offers insights that might apply to other institutions. It suggests that implementation of a sustainable supply chain requires all recommended suppliers to ensure that their ethical and sustainable practices are consistent and maintained, and implies greater transparency within the supply chain. Ensuring that all purchasers within the university use the accredited suppliers can present challenges, however, and training may be needed to ensure that policies are implemented at every level.

The university's procurement policy is to conform, wherever possible, to a closed loop system in which all IT products

BOX STORY 4

Repair, upcycling and collaborative consumption

Product repair in community settings, the upcycling of discarded products, components or material into higher value products, and collaborative consumption (i.e. sharing, swapping, bartering, trading, renting) are practices that appear to have grown in recent years.

Such practices reuse waste, bring underutilised products back into service, extend product lifetimes or increase the intensity of use. Each case implies environmental benefits, including reductions in virgin material use. New jobs and market opportunities have been created around repair (e.g. The Restart Project, Repair Cafés), upcycling (e.g. Remade in Britain, independent sellers on Folksy and Etsy) and collaborative consumption (e.g. Zipcar, SwapTrees, Ebay), while participants may save money by avoiding having to purchase wholly new products. These activities are not only environmentally and economically beneficial, but often help individuals gain new practical skills and knowledge while offering enjoyable life experiences.

(for example) are recycled or remanufactured when they reach the end of their lives. This example revealed similar obstacles to those experienced at household level, such as barriers to leasing and repair. Design strategies that support the optimisation of product life and product life extension for households could also be influential at institutional level. While the case offered insights into how sustainability is incorporated into procurement policies and practice, further research with other institutions is needed in order to identify barriers to and triggers for change more definitively.

This section has presented some of the barriers to and triggers for change in relation to households, industry and institutions. Future research will develop this and consider the interrelationship between them. The following section discusses how to achieve a transition towards a low material consumption future.

Local economies of repair to minimise material consumption: The Restart Project

BOX STORY 5

The Restart Project is a London-based charity and social enterprise which encourages people to use electronic products for longer through a collaborative repair process in which learning and skill-sharing opportunities, together with inspirational talks, are offered.

Founded in 2012, the project has hosted 85 community events, attended by a total of 1,379 participants. In the process it has prevented 1,270kg of electronic waste, equivalent to 25.8 tonnes of carbon emissions, while equipping people with skills and knowledge of repair as well as more general sustainable lifestyle knowledge (e.g. product end-of-life options).

Ugo Vallauri, one of the founders, argues that, given the escalating number of volunteers and participants, there is potential to develop 'local economies of repair', and that community repair initiatives such as the Restart Project could inspire the emergence of more sustainable business models. In line with his future vision of a 'people-centred circular economy', the project has been working to scale-up repair initiatives, organising workshops for new start-ups, offering an international consultation service, and preparing on-line start-up toolkits. Key factors that enable repair initiatives to be successful are said to include 'radical openness' (anyone may attend, even people with no relevant skills or knowledge), making events accessible and fun, creating an environment based on mutual learning (participants learn by doing, not mere teaching) and organising events that help to build a community.

How can the transition towards low material consumption be made?

Innovative practices, new policies and incentives are required to transform the prevailing throwaway culture to one that is more material-conscious. Market conditions need to support radical innovations, while governments need to understand consumer behaviour better and use the findings alongside economic and environmental indicators.

Defining transitions

Research suggests that meeting UK territorial (i.e. production-based) climate change targets is technically feasible, but this will not ensure that UK consumer-driven impacts decrease. Changes in consumption would complement the widescale deployment of low carbon energy technologies, and decrease reliance on technologies such as carbon capture and storage which are unproven at scale.

In order to bring about major such change, there is a need for a transition involving transformations in the way that society functions in terms of its transportation, housing and other requirements. The need for transition to a low carbon economy has recently attracted theoretical development. Transition theories suggest that transformation on multiple levels is required, from marginal groups of people (i.e. niches) to broader segments of population (i.e. the socio-technical context) (see Figure 6).

New and potentially less damaging practices are more likely to be triggered by relatively small groups of people before being adopted by larger communities and, finally, society as a whole. The niche level provides a space for learning with fewer constraints, enabling more radical innovations to evolve. There is often a steep learning curve for new practitioners of less damaging practices, and their performance and economic viability need to be demonstrated before being embedded in the prevailing system. Pressure can then be exerted on the system (or 'regime'), challenging mainstream technologies, social practices, organisational infrastructure and policies, whereby, given the right incentives, change can be achieved. The potential for change becomes incremental at 'landscape' level, where cultures, norms and political systems are firmly ingrained in society and change takes place only slowly.

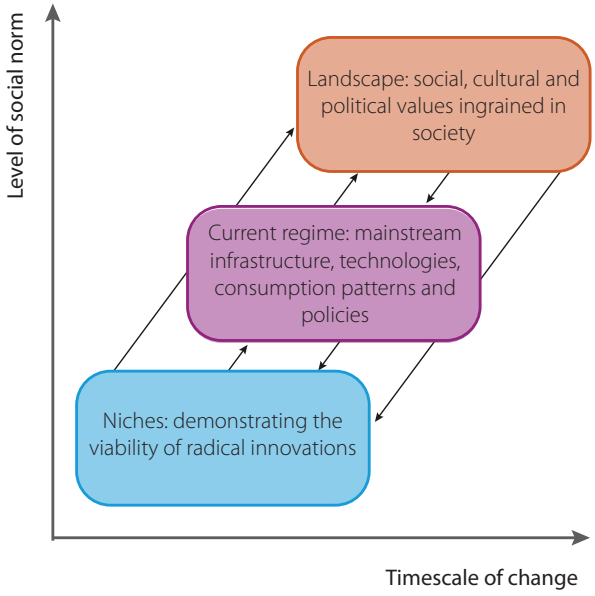


Fig 6: Levels of social norms and factors involved in processes of transition over time
Source: Adapted from Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes, Research Policy, 31(8), 1257-1274.

Interactions between these three levels can, over time, enable radical change in mainstream markets. Factors that are external to the new practitioners can put pressure on mainstream behaviours: regulatory and policy changes and media coverage can modify societal norms; new technologies and practices can alter user preferences; and strategic initiatives by firms to increase their competitiveness can change the economic system (for example, the transition to a service-based economy). Internal factors can stimulate the diffusion of innovations, such as changes in perceptions, rules and socio-technical linkages.

Any transformation process is affected by the dynamics at these different levels. Box Story 6 shows how the niche 'maker culture' has spread by interacting with and becoming part of the upper levels of social norms.

How to facilitate the transition to a low material consumption future

The current growth of innovative practices at the niche level supports the business case for transition to a low material consumption future. For instance, Zip Car is a car-sharing club which increases car use intensity, while at swishing events people bring unwanted clothing to swap with others in order to extend garment life-spans. Various changes that are taking place in habits and lifestyles and initiatives reveal that opportunities exist for a transition towards a low material consumption

future with different social norms. Box Story 4, above, describes examples of niche movements for repair, upcycling and collaborative consumption. The conditions for bringing these into the mainstream, such as market dynamics and incentives, need to be better understood.

Design and policy are potential facilitators of the necessary transition towards a low material consumption future. Research is currently investigating the potential innovation that design can generate.[9] The relevance of sustainable design theory and practice to the first two stages in the product lifecycle presented above (Figure 5) has been acknowledged, most notably through the EU Ecodesign Directive, although more investigation on the latter two stages is required.

Public policy has hitherto generally focused on technical solutions to promote efficiency improvements. However, at the current 'regime' level research involving more direct observation of consumers' behaviour and practices might ensure that policy is able to tackle drivers of consumption beyond efficiency measures. Resource efficiency strategies have so far focused on energy performance (e.g. through the EU Ecodesign Directive) and end-of-life disposal options (e.g. the WEEE Directive), but consumption has continued to rise. As noted above, energy-efficiency can be offset by the 'rebound effect', in which monetary savings from reduced consumption increases demand for the same or another product.

Policy interventions to change consumer attitudes and behaviour have used labelling (e.g. EU Energy Labelling Directive and EU Ecolabel Scheme) or provided economic incentives (e.g. car scrappage schemes). However, product labelling has been restricted mainly to energy use, product prices are still not reflective of social and environmental costs, and environmental benefits indicated by labels might not be recognised by consumers. In short, decisions are not necessarily determined by increased information and economic incentives.

Radical policy is needed to reduce the consumption of materials through change at the 'landscape' level. For example, there is a need to redefine progress and how to measure it. Future research will study in depth the kind of policy measures necessary to create a low material consumption future.

The transition to a maker subculture in a 'new DIY age'

BOX STORY 6

An example of a current transition is popular interest in the 'maker' subculture. Within our mass production and consumption system, individuals appear increasingly interested in producing artefacts, sometimes collaboratively. Niches of makers or 'fabbers' have gradually spread over the last decade, perhaps due to a combination of different windows of opportunities at the regime and landscape levels, such as the development of web-based platforms for collaborative design (e.g. Shapeways, Ponoko), the decreased price of rapid prototyping technologies (e.g. 3D printers, domestic CNC machines), industry interest in consumer involvement (e.g. mass customization, co-design), and the introduction of local infrastructures for production (e.g. TechShop, Fab Lab). Committed amateurs can generate innovative ideas; for instance, users of scientific instruments have been acknowledged as developers of around 80% of the most important innovations.

In this 'new DIY age', local government and other institutions are considering the economic benefits and social impacts of these productive places. In Spain, the city council of Barcelona plans to establish a network of Fab Labs, workshops equipped with production machinery and tools, in every neighbourhood. This suggests a potential trend for the contemporary maker culture to become part of the landscape level. Fab Labs are also spreading in the UK: the Fab Lab in London has recently triggered a partnership with the Royal Society of Arts to address resource efficiency and waste minimization in their project, The Great Recovery, which aims to bring together stakeholders from across the materials lifecycle.

What are researchers doing about this?

This report has attempted to shed light on: (1) the impact of UK consumption on global material and energy demand, (2) complex influences on consumption and consumer behaviours at household, industry and institutional levels, (3) the perception of value beyond monetary terms, (4) the role of design in supporting low material consumption at different levels and (5) barriers, triggers and pathways for scaling-up marginal but meaningful practices initiated by design strategies and interventions.

The work undertaken in the first year of the research centre has presented some opportunities to clarify the evidence about current material demand, and to influence it in the future. These include:

- Developing models and theories to understand changes in consumption at household level, e.g. how theories from different disciplines can be integrated to provide a more holistic perspective of consumption and propose actions for change.
- Better understanding of decision-making processes in industry and institutions, e.g. how decision makers can be informed about the implications of excessive material demand and supported to reduce its impact.
- Estimating environmental and social benefits from different design strategies, e.g. which strategies can provide greater environmental benefits through the reduction of material demand while satisfying socio-economic needs.
- Understanding the linkages between sustainable development indicators and low material strategies, e.g. how to measure the impact of the strategies in order to inform and develop policy interventions.

Notes

1. Assuming the absence of low carbon fuels, novel highly efficient technologies, or carbon capture and storage.

2. The institution studied was Nottingham Trent University.

3. Rokeach M. (2008) Understanding Human Values. Simon and Schuster.

4. For further details see http://www2.ntu.ac.uk/purchasing/policiesandprocedures/SustainableGuide.htm

5. Each strategy is necessarily determined at the design stage. The classification presented considers where the major changes will take place along the supply chain and product lifecycle although the same strategy can have effects at different stages.

6. The best known approaches are 'Design for sustainable behaviour, which is grounded in psychological theories, and 'Practice-oriented design, which is grounded in social practice theory. However, these design approaches have mainly focused on everyday impacts of consumption such as bathing, laundry, and food preparation and storage and not on material demand and its impacts. Therefore the proposed strategies for this category are focused on optimising product life during use, which is more related to material demand.

7. See the Happy Planet Index at http://www.happyplanetindex.org/

8. See Box Story 4 for further reflection of the potential of collaborative consumption to promote change.

9. Design has the potential to become an integral part of European innovation policy (Commission of the European Community, 2009. Working document 'Design as a driver for user-centred innovation'). The European Design Innovation Initiative was launched in 2011 to exploit the full potential of design-driven innovation and aims to reinforce links between design, innovation and competitiveness.